City of Memphis
Maynard C. Stiles Wastewater Treatment Plant
Disinfection Improvements

Pilot Study Phase 5 Summary
May 1, 2015

Background

The objective of the full-scale peracetic acid (PAA) pilot study is to identify the best disinfection control strategy to achieve compliance with the future NPDES permit disinfection limits under varying flows and influent quality conditions. The Pilot Study Work Plan, previously developed and approved in 2014, includes a description of Dose Control Strategy, Phases of Testing, Data Analysis, Pilot Study Management, and Additional Industrial User Testing to be conducted.

The pilot is being conducted in phases; the first four include development of information on the best means of providing dose control. A fifth phase will be used to demonstrate efficacy of the final process control algorithm. Data collected during the pilot will be used to inform the final design of the dose control for the full-scale system design. This document provides a summary of the results of Phase 5.

Phase 5: Implementation

The wastewater from the north and south sides of the plant meet and discharge into the mixing compartment at the head of the contact tank. The combined flow is split into two parallel, serpentine contact channels. Pre-disinfection water quality, including color, chemical oxygen demand (COD), and undisinfected *E. coli*, is assessed at the head of the disinfection channel that is not receiving PAA. The water quality parameters are being measured continuously on-line, during this phase are as follows:

- Color - ChemScan UV-3151 series flow-thru sensor
- COD - YSI CarboVis 701 submersible probe

PAA residuals were measured throughout the disinfection channel by three separate, Ducotest Amperometric PAA sensors, P1, P2 and P3, as shown in Figure 1. Undisinfected bacterial samples were collected near the water quality probes on the untreated side of the basin, final disinfected bacterial samples were collected near location P3 as shown in Figure 1.

Using data from Phase 1, color and COD were selected as parameters to serve as a feed forward parameter in a dose control strategy based on the quality of fit between PAA demand and wastewater color or COD. Additional testing was conducted in Phases 2, 3 and 4 to refine the dose algorithm. The PAA dose in Phase 5 was based on a PAA setpoint dose and adding additional PAA that is equivalent to the calculated demand from the wastewater characteristics, as shown in Equation 1. Here, the PAA demand is calculated as a function of color or COD, as determined during previous phases of work.

$$PAA_{dose} = PAA_{setpoint} + PAA_{demand} \qquad \textbf{Equation 1}$$

In preparation for Phase 4, a new flow meter was installed on January 31 to improve the accuracy of flow measurement during the trial. Based on the results of Phases 2 and 3, in Phase 4, color was

continuously monitored as described above, and the chemical feed pump PLC calculated PAA demand from the measured color. The color demand value was added to the target setpoint to pace chemical feed. During the month of Phase 4 testing, the $PAA_{setpoint}$ was optimized. Phase 5 was implemented to provide demonstration of the optimized dose algorithm.

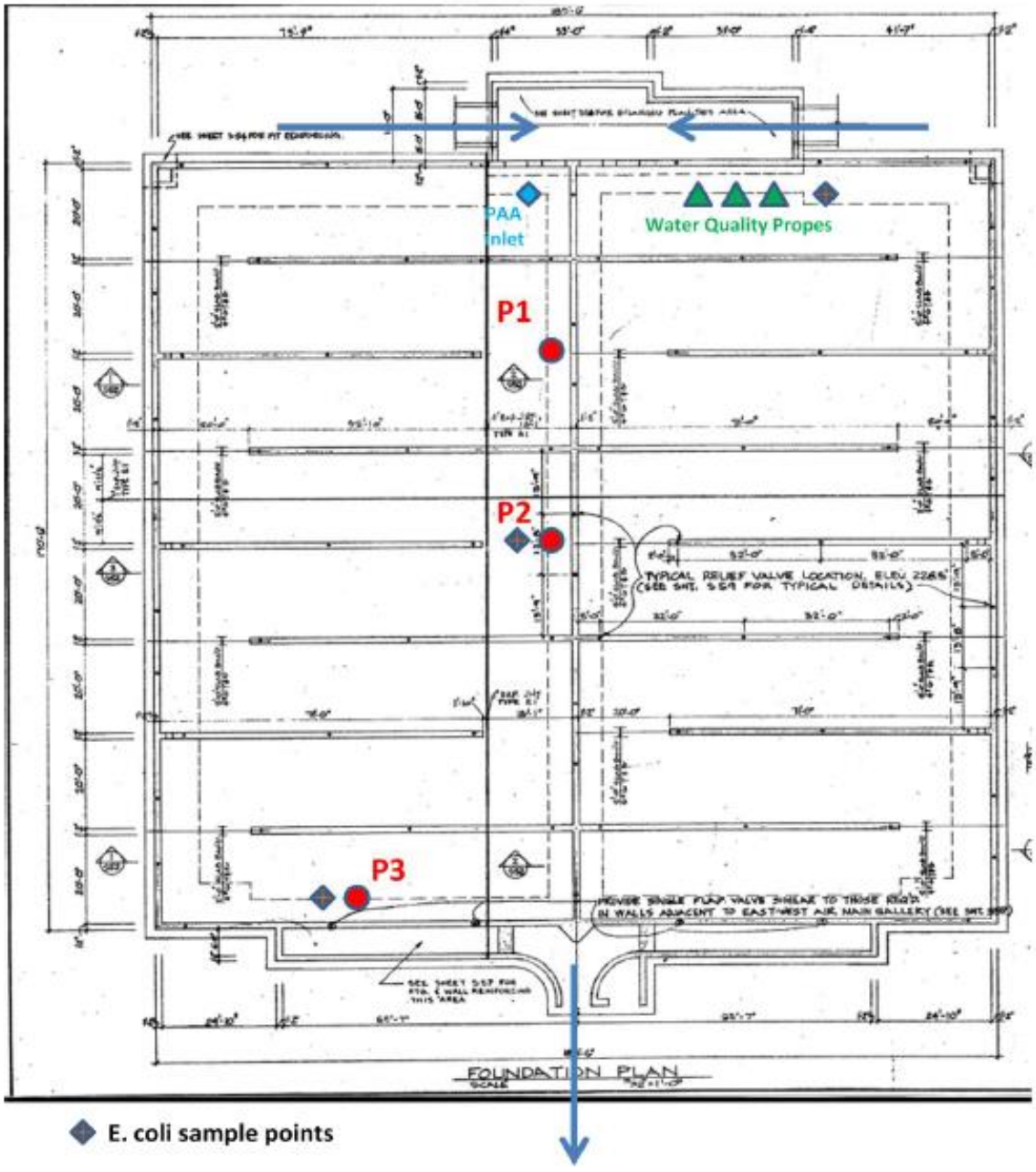

Figure 1. Water quality monitoring and sampling locations in disinfection contact tank.

Phase 5: Results

Phase 5 was initiated on March 6, 2015 and concluded on April 4, 2015. The new flow meter provided stable and improved readings throughout the entirety of Phase 5, and as a result the flow based control

was also stable. Data for PAA dose was plotted along with effluent color, and PAA residual measured at Probe 1, and is provided in Figure 2. The PAA residuals at P2 and P3 were periodically near the detection limit of the analyzer throughout the phase and are not shown; as a result, the analysis of Phase 5 data is based on the residuals reported at P1, which are shown in Figure 3 along with *E. coli* results.

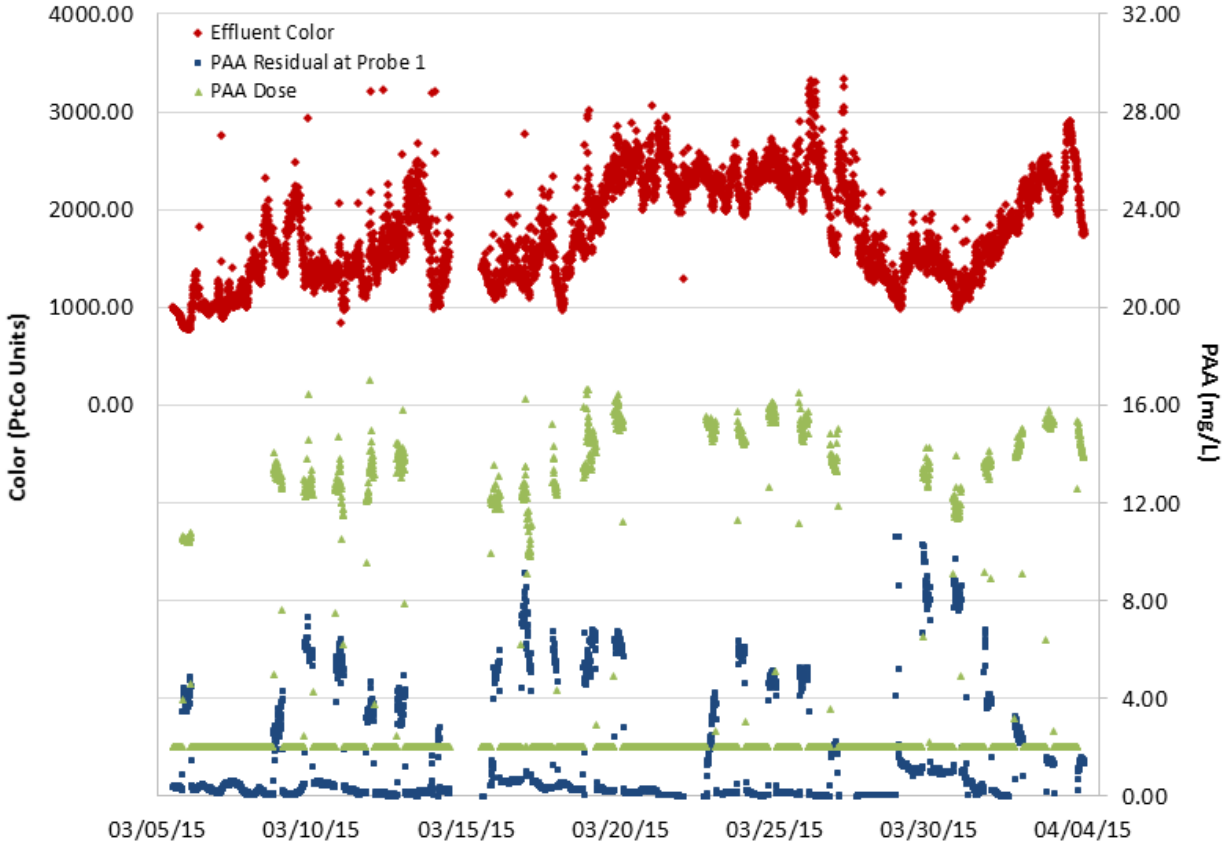

Figure 2. Color, PAA dose and PAA residual measurements during Phase 5.

As noted in the previous Phase 4 report, a PAA "conservation" program was initiated on Saturday, February 21st. The conservation program consisted of reducing the dosage of PAA into the disinfection chamber to a flow-paced 2 ppm, during periods when *E. coli* sampling does not occur (weekends and evening hours). This practice can be observed in Figure 2, which shows the PAA dose and residual in green and blue symbols, respectively. It was shown that this reduction in off-hour PAA usage did not negatively interfere with *E. coli* testing during the weekday sampling periods and does not impact the demonstration of PAA efficacy. Because there are no technical issues associated with this reduction in off-hour PAA usage, this practice was continued throughout the pilot study as a significant cost-savings to the City.

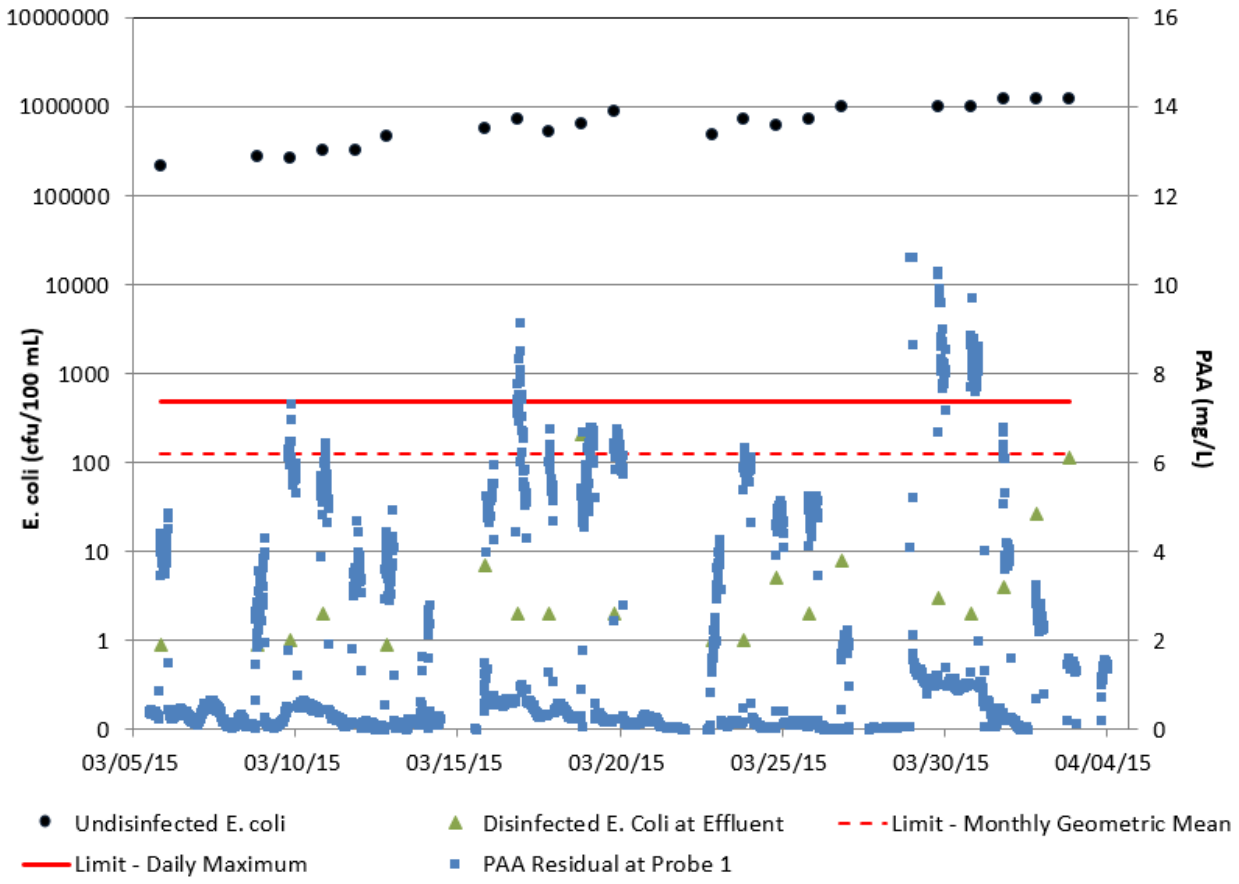

Figure 3. *E. coli* results and PAA residual measurements at Probe 1 during Phase 5.

Results of the bacteria testing in previous phases showed that color was an excellent feed forward parameter for managing disinfection process control. Phase 5 was completed on April 4, 2015; and as shown in Figure 3, the PAA setpoint determined from previous Phases met the 126 cfu/100 mL criteria except for on one day during a high color event. Even though the March 19 sample did not meet the monthly geometric mean limit, it would have still been in compliance because it was less than the maximum daily limit of 487 cfu/100 mL.

Summary and Future Work

Based on the results of this Phase of testing, as anticipated from data collected during previous Phases, color is strongly correlated to disinfection performance. This parameter, which was also used for feed forward during Phase 4 proved to be an excellent process control parameter for managing disinfection. The entire month of Phase 5 data demonstrated that PAA fed using dose pacing with a feed forward control based on color is an optimal means of meeting disinfection compliance.

Using the information collected in this study, the City will complete design of the disinfection system so that it can be put into operation to meet the compliance schedule outlined in the current draft National Pollutant Discharge Elimination System permit.